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Prospects for electricity generation from the wind potential of Zamala in Cameroon

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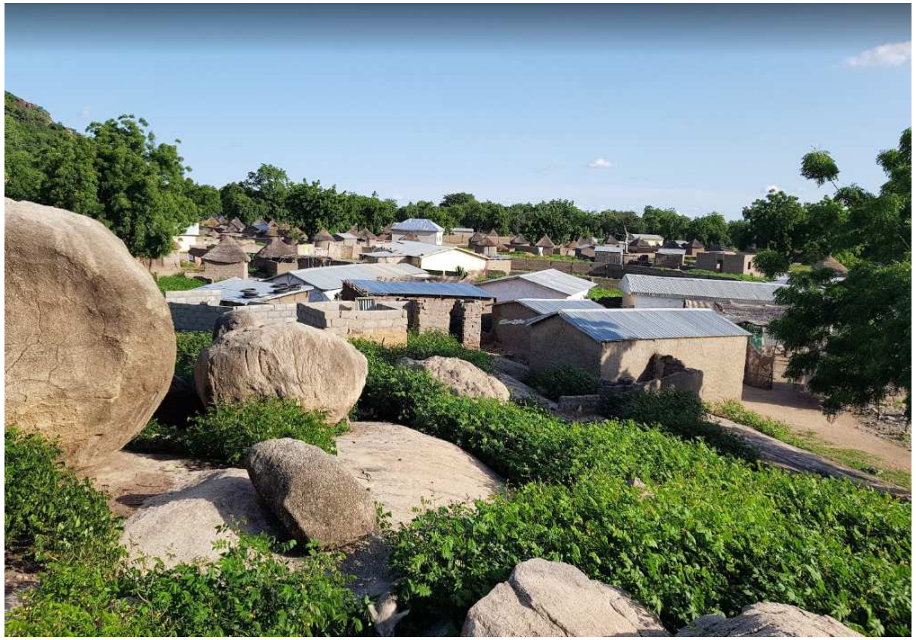
Outline

- Problem statement
- Aim of the study
- Methodology
- Results
- Conclusion



ZAMALA

500 people

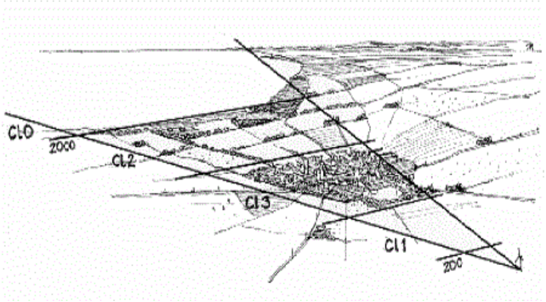
Main activities: Agriculture and cattle farming

Problem: lack of electricity supply

Aim of the study

- Determine if wind can be used as a resource for electricity generation in Zamala;
- In the case it is favorable, determine if the power that could be generated can cover the electricity needs of Zamala's people.

Collection and processing of data



Wind

Roughness

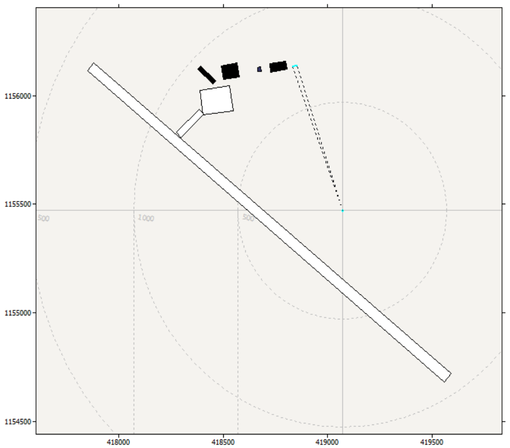
Data

Topography

Obstacle

1h measurement

- Speed (m/s)
- Direction (°)



SRTM Data

1 Arc-second

Jet Propulsion Laboratory
California Institute of Technology

Modelling of the observed wind speed distribution

Weibull's Probability Density Function

$$f(v) = \frac{k}{C}\left(\frac{v}{C}\right)^{k-1} exp\left[-\left(\frac{v}{C}\right)^{k}\right] \qquad (1)$$

Modified Maximum Likelihood Method (*Seguro and Lambert, 2000*)

$$k = \left(\frac{\sum_{i=1}^{n} v_i^k Ln(v_i) f(v_i)}{\sum_{i=1}^{n} v_i^k f(v_i)} - \frac{\sum_{i=1}^{n} Ln(v_i) f(v_i)}{F(v \geq 0)}\right)^{-1} \qquad (2)$$

$$C = \left(\frac{1}{F(v \geq 0)} \sum_{i=1}^{n} v_i^k f(v_i)\right)^{\frac{1}{k}} \qquad (3)$$

Mean wind speed and Energy density (*Boudia et al., 2015*)

$$\bar{V} = C\,\Gamma\left(1 + \frac{1}{k}\right) \qquad (4)$$

$$E_D = \frac{1}{2}\rho C^3 \Gamma\left(1 + \frac{3}{k}\right) \qquad (5)$$

Modelling of the power curve

$$P_T(v) = \frac{P_{i+1} - P_i}{v_{i+1} - v_i}(v - v_i) + P_i \qquad (6)$$

$$P_{EL} = \int_{V_d}^{V_n} P_T(v)\, f(v) dv + P_n \int_{V_n}^{V_a} f(v) dv \qquad (7)$$

$$E_{EL} = P_{EL} * N_H \qquad (8)$$

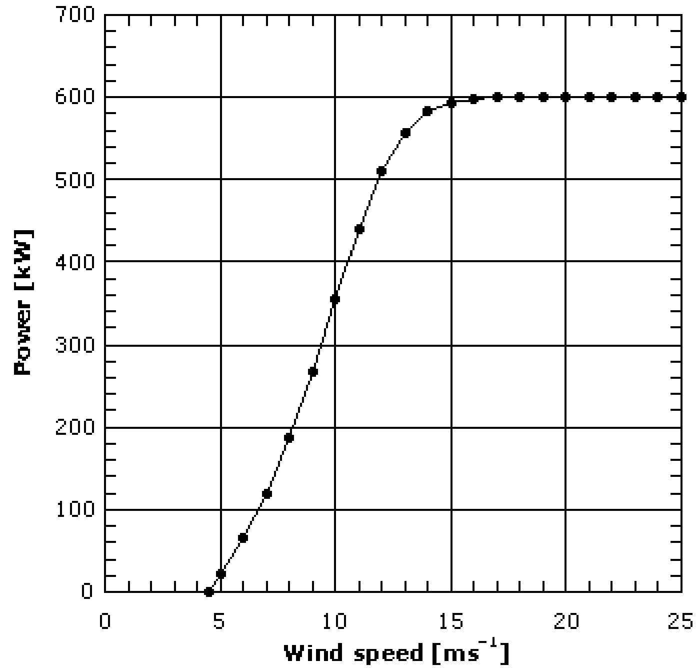


Fig. 1 Actual power curve is approximated by a piece-wise linear function with few nodes. (*Carta et al., 2008*)

Collection and processing of data

Table 1: Wind speed statistics in frequency

Wind speed (m/s)	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11
Freq (%)	34.35	4.78	15.57	18.37	15.66	9.17	1.48	0.47	0.05	0.05	0.05

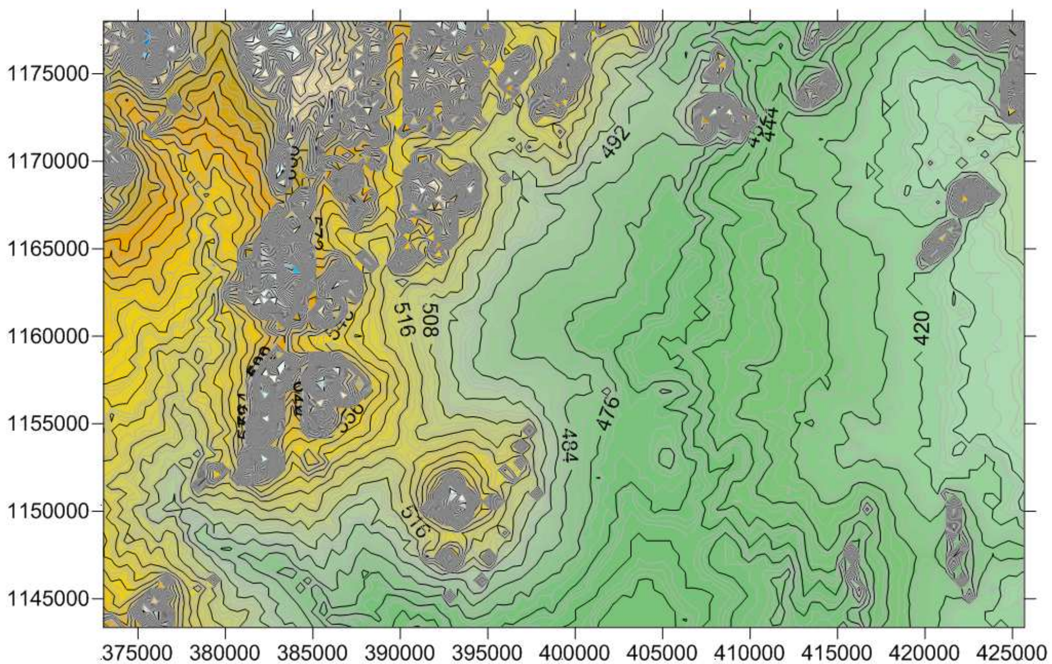


Fig. 2 Topographic map of our site

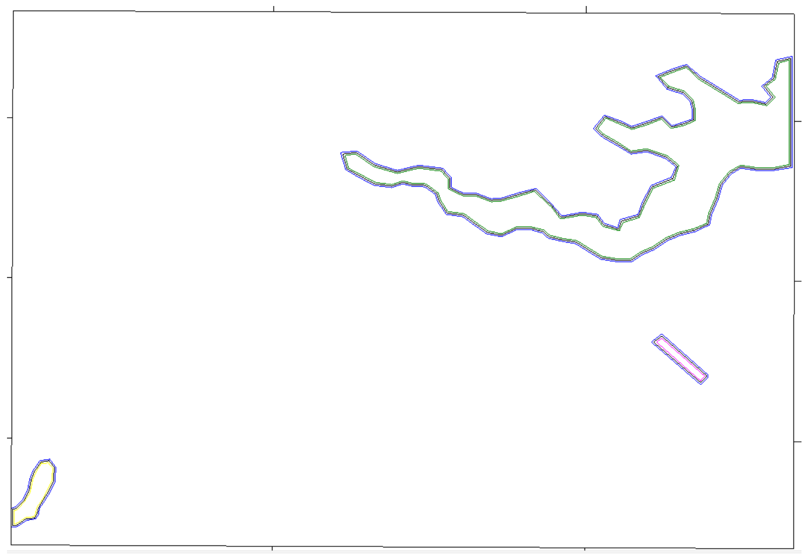


Fig. 3 Roughness map of the site

Modelling of the observed wind speed distribution

Table 2: Wind parameters at 10 m agl

	k -	C (m/s)	$\bar{V}^{10\,m}$ (m/s)	E_D^{10m} (W/m²)
Our results	1.3222	2.8507	2.6241	36.8782
From WAsP	1.910	3.200	2.680	29.00

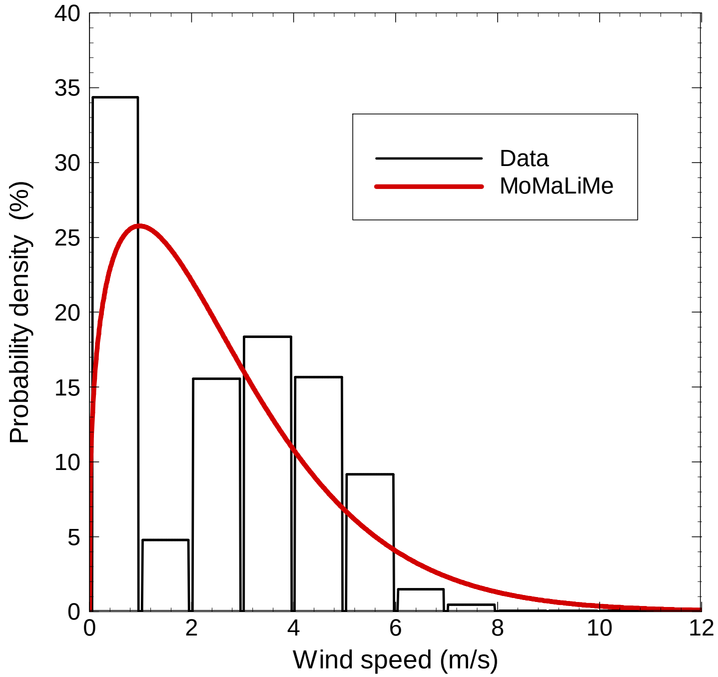


Fig. 4 Wind speed histogram fitted by the Weibull PDF

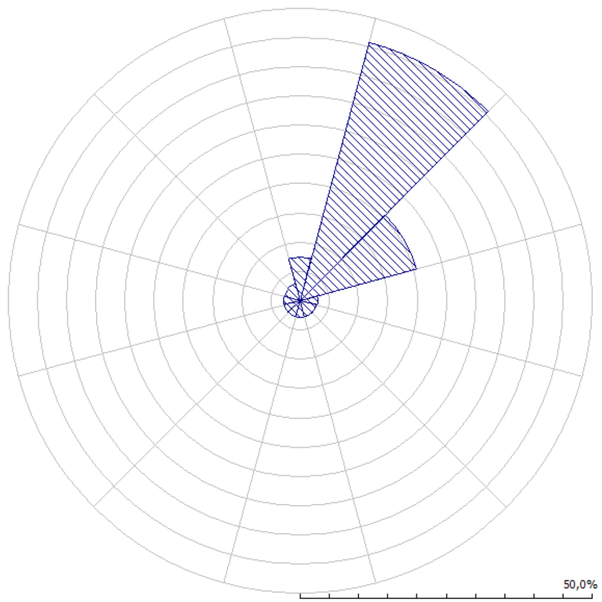


Fig. 5 The wind rose of the airport site

Computations with WAsP

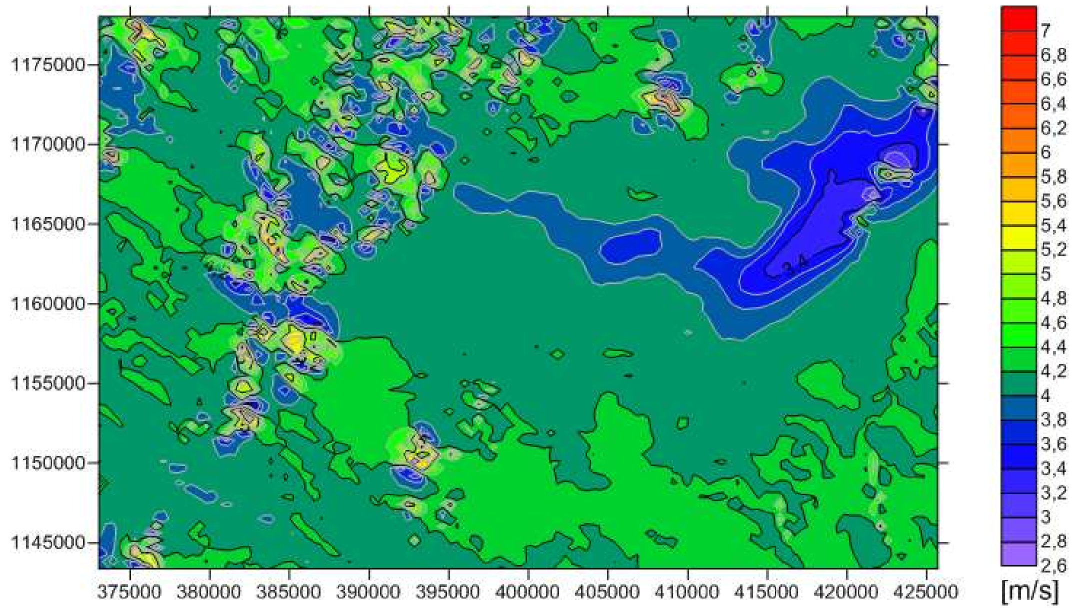


Fig. 6 The wind speed map

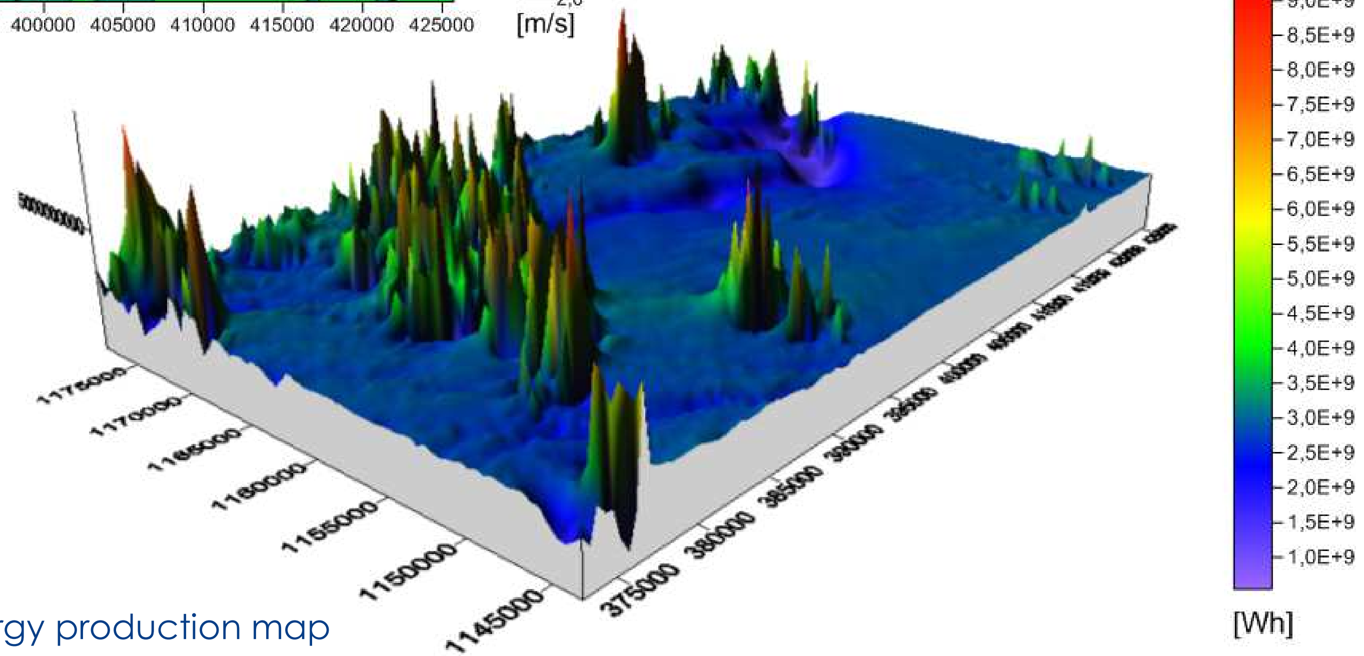
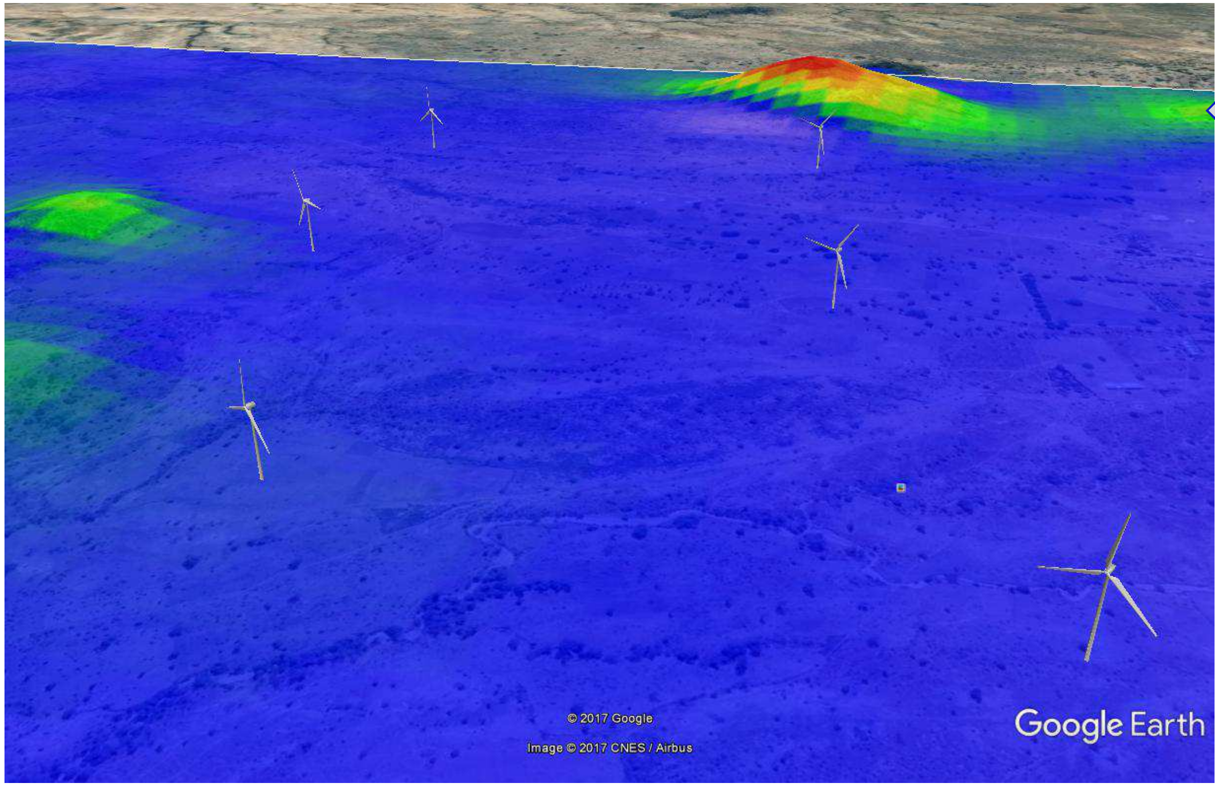


Fig. 7 The annual energy production map



hypothetical wind farm

06 turbines Nordex 2.5 MW

AEP = 16,330 MWh

CO_2 Emissions saved: 3300 tons/year

Fig. 8 Map of the initial feasibility of the wind farm

Table 3: The wind turbine siting and their annual energy production

Site description	X-location [m]	Y-location [m]	Elev. [m]	U [m/s]	Gross [GWh]	Net. [GWh]	Loss [%]
Turbine site 001	395566.5	1152491.0	527.6	4.23	2.973	2.973	0.0
Turbine site 002	394835.3	1152534.0	532.1	4.14	2.756	2.756	0.0
Turbine site 003	395100.7	1151895.0	530.5	4.13	2.741	2.447	10.72
Turbine site 004	395889.7	1151894.0	526.1	4.17	2.841	2.8408	0.01
Turbine site 005	395223.7	1151179.0	531.1	4.09	2.663	2.566	3.67
Turbine site 006	396027.6	1151215.0	519.7	4.14	2.754	2.746	0.27

Conclusion

The wind potential of our site is favourable for an electricity generation from wind power;

An initial feasible wind farm consisting of 06 Nordex wind turbine would yield an AEP of 16,330 MWh;

Expectations about Africa-EU research collaborations

- Deep studies of the project
- Realization of the project in the future

ACKNOWLEDGMENTS

- Africa-EU Renewable Energy Cooperation Programme (RECP),
- NULISTICE-RERIS Organizing Committee

Thank you for your kind attention !